Question	Answer	Marks
6(a)	period = 5.0 μs, so frequency = 2.0×10^5 Hz	**A1**
6(b)	sketch: three equally spaced vertical lines sitting on *f*-axis	**B1**
	two outer vertical lines of equal length and central line longer	**B1**
	three vertical lines (and no others) shown at frequencies 190 kHz, 200 kHz and 210 kHz	**B1**

Question	Answer	Marks
7	X-rays are used	**B1**
	section (of object) is scanned	**B1**
	scans/images taken at many angles/directions **or** images of each section are 2-dimensional	**B1**
	images of (many) sections are combined	**B1**
	(to give) 3-dimensional image of (whole) structure	**B1**

Question	Answer	Marks
8(a)	magnitude: (force =) Bqv	**B1**
	direction: P→Q **or** E→F **or** S→R **or** H→G	**B1**
8(b)(i)	EHSP and FGRQ	**B1**
8(b)(ii)	PE **or** QF **or** RG **or** SH	**B1**
8(c)(i)	*any one correct starting point from:* • (mass of 1 atom =) $27 \times 1.66 \times 10^{-27}$ • (amount of substance per unit volume =) 2.7 / 27 • 27 g (of substance) contains 6.02×10^{23} atoms • (2.7 g mass contains) 0.1 mol • (1 cm^3 volume contains) 0.1 mol • (1 m^3 volume contains) 10^5 mol	**C1**
	$n = (2.7 \times 10^3) / (27 \times 1.66 \times 10^{-27}) = 6.0 \times 10^{28}$ **or** $n = (2.7 / 27) \times 10^6 \times 6.02 \times 10^{23} = 6.0 \times 10^{28}$	**A1**
8(c)(ii)	$V_H = (0.15 \times 4.6) / (6.0 \times 10^{28} \times 0.090 \times 10^{-3} \times 1.60 \times 10^{-19})$	**C1**
	$= 8.0 \times 10^{-7}$ V	**A1**

Question	Answer	Marks
9(a)	work done per unit charge	**B1**
	(work done) moving positive charge from infinity	**B1**
9(b)(i)	energy $= 4.8 \times 1.60 \times 10^{-13}$ $= 7.7 \times 10^{-13}$ J	**A1**
9(b)(ii)	$E_P = Qq / 4\pi\varepsilon_0 d$	**C1**
	$Q = 79e$ **and** $q = 2e$	**C1**
	$7.68 \times 10^{-13} = (79 \times 2 \times \{1.60 \times 10^{-19}\}^2 / (4\pi \times 8.85 \times 10^{-12} \times d)$	**C1**
	$d = 4.7 \times 10^{-14}$ m	**A1**
9(c)	(diameter must be) less than/equal to 10^{-13} or 10^{-14} m	**B1**

Question	Answer	Marks
10(a)	(as temperature rises) electrons in valence band gain energy	**B1**
	electrons jump to conduction band	**B1**
	holes are left in the valence band	**B1**
	increased <u>number</u> (density) of charge carriers causes lower resistance	**B1**
10(b)(i)	$V^- = V^+$	**C1**
	$1.50 / 1.20 = R_T / 1.76$	**C1**
	$R_T = 2.2$ (kΩ)	**C1**
	temperature = 14 °C	**A1**
10(b)(ii)	(For LED to conduct,) V_{OUT} must be negative	**B1**
	$V^- > V^+$	**B1**
	R_T must be lower so temperature must be above **(b)(i)** value	**B1**

Question	Answer	Marks
11(a)	(induced) e.m.f. proportional to rate	**M1**
	of change of (magnetic) flux (linkage)	**A1**
11(b)(i)	any two from t_1, t_3, t_5, t_7	**A1**
11(b)(ii)	t_2 **and** t_4 **or** t_4 **and** t_6	**A1**
11(c)	e.m.f. = $N\Delta\Phi / \Delta t$	**C1**
	= $(2 \times 9.4 \times 10^{-4} \times 5.0 \times \pi \times (1.8 \times 10^{-2})^2 \times 63) / (6.0 \times 10^{-3})$	**C1**
	= 0.10 V	**A1**

Question	Answer	Marks
12(a)(i)	(decay is) unpredictable/cannot be predicted	**B1**
12(a)(ii)	probability of decay (of a nucleus)	**M1**
	per unit time	**A1**
12(b)	$A = \lambda N$	**C1**
	(for 1.00 m^3) $A = 0.600 / 4.80 \times 10^{-3}$ (= 125 Bq)	**C1**
	$N = 125 / ([7.55 \times 10^{-3}] / 3600)$ $(= 5.96 \times 10^7)$	**C1**
	so ratio = $(2.52 \times 10^{25}) / (5.96 \times 10^7)$	**C1**
	or	
	(for 4.80×10^{-3} m^3) N for air = $2.52 \times 10^{25} \times 4.80 \times 10^{-3}$ $(= 1.21 \times 10^{23})$	**(C1)**
	N for radon = $0.600 / ([7.55 \times 10^{-3}] / 3600)$ $(= 2.86 \times 10^5)$	**(C1)**
	so ratio = $(1.21 \times 10^{23}) / (2.86 \times 10^5)$	**(C1)**
	ratio = 4.2×10^{17}	**A1**